NAVAL EDUCATION AND TRAINING PROGRAM
MANAGEMENT SUPPORT ACTIVITY
PENSACOLA, FLORIDA 32509-5000

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Specific Instructions and Errata for
NAVY ELECTRICITY AND ELECTRONICS TRAINING SERIES
MODULE 11 - MICROWAVE PRINCIPLES
TRAINING MANUAL (TRAMAN) NAVEDTRA 172-11-00-87

1. THIS ERRATA SUPERSEDES ALL PREVIOUS ERRATA.

2. This errata does not include errors in typing, punctuation, etc., that do not affect your ability to answer the questions.

3. Make these changes in your course booklet, NAVEDTRA 172-11-00-87, before you begin the course.

Topic	Change
# 1	Page 1-14 -- Insert new page 1-14 and X-out old page.
	Page 1-16 Figure 1-33(A) -- White-out Ø symbol.
	Page 1-26 Figure 1-51(A) -- Pen and ink change point 2 to point 3 and point 3 to point 2 (switch numbers).
	Page 1-45 Figure (A) CHOKE JOINT -- Pen and ink change point 2 to point 3 and point 3 to point 2 (switch numbers).
# 2	Page 2-11 Figure 2-9 -- Write "(OUTPUT)" above "MAGNETIC COUPLING LOOP".
	Page 2-46 REFLEX KLYSTRON figure -- Write "(OUTPUT)" above "MAGNETIC COUPLING LOOP".
# 3	Page 3-3 -- Pen and ink change under "Radar Fundamentals" paragraph 3 line 19 replace "30 degrees" with "60 degrees".
	Page 3-3 Figure 3-1 -- Write "090T" below the word "EAST".
	Page 3-7 -- Pen and ink change under "HORN

RADIATORS" paragraph 1 line 2 change "HORN REFLECTORS" to read "HORN RADIATORS".

The wavefront is shown in view (a) as small particles. In views (B) and (C) particle 1 strikes the wall and is bounced back from the wall without losing velocity. If the wall is perfectly flat, the angle at which it strikes the wall, known as the angle of incidence (θ), is the same as the angle of reflection (ϕ) and are measured perpendicular to the waveguide surface. An instant after particle 1 strikes the wall, particle 2 strikes the wall, as shown in view (C), and reflects in the same manner. Because all the particles are traveling at the same velocity, particles 1 and 2 do not change their relative position with respect to each other. Therefore, the reflected wave has the same shape as the original. The remaining particles as shown in views (D, (E) and (F) reflect in the same manner. This process results in a reflected wavefront identical in shape, but opposite in polarity, to the incident wave.

Figure 1-27, views (A) and (B), each illustrate the direction of propagation of two different electromagnetic wavefronts of different frequencies being radiated into a waveguide by a probe. Note that only the direction of propagation is indicated by the lines and arrowheads. The wavefronts are at right angles to the direction of propagation. The angle of incidence (θ) and the angle of reflection (ϕ), of the wavefronts vary in size with the frequency of the input energy, but the angles of reflection are equal to each other in a waveguide. The CUTOFF FREQUENCY in a waveguide is a frequency that would cause angles of incidence and reflection to be zero degrees. At any frequency below the cutoff frequency, the wavefronts will be reflected back and forth across the guide (setting up standing waves) and no energy will be conducted down the waveguide.

The velocity of propagation of a wave along a waveguide is less than its velocity through free space (speed of light). This lower velocity is caused by the zigzag path taken by the wavefront. The forward-progress velocity of the wavefront in a waveguide is called GROUP VELOCITY and is somewhat slower than the speed of light.

The group velocity of energy in a waveguide is determined by the reflection angle of the wavefronts off the "b" walls. The reflection angle is determined by the frequency of the input energy. This basic principle is illustrated in figure 1-28. As frequency is decreased, the reflection angle decreases causing the group velocity to decrease. The opposite is also true; increasing frequency increases the group velocity.

Q14. What interaction causes energy to travel down a waveguide?

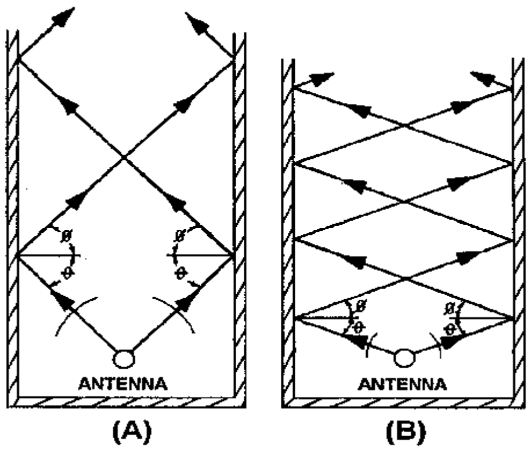

Figure 1-27.—Different frequencies in a waveguide.

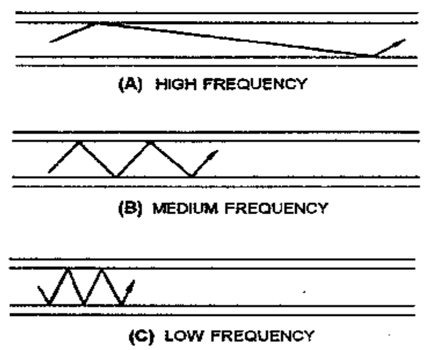

Figure 1-28.—Reflection angle at various frequencies.